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A BRIEF SURVEY ON RADIATION EFFECTS AND LINEAR BLOCK CODES FOR ELECTRONICS PROTECTION

Abstract

In this paper,we first give a brief discussion on the radiation effects to space electronics and then survey a class of typical and efficient electronics protection methods as Linear Block Coding (LBC).

CMOS circuits, of this kind of manufacturing for moderm electronics, exposed to radiation or electromagnetic environments would suffer from multiple effects which could corrupt the data in electronic components, such as the most susceptive components as memories and registers.

In space environment, typical effects for electronics are SEE(Single Event Effects). However,as the semiconductor feature size continuously shrinking into sub-nanometer, the geometric effects of multiple errors have exceeded previous regimes. Multiple corruptions, as double or even triple errors have been observed in launching vehicles. An optimal mechanism against not only single error effects (SEE), but also multiple errors effects (MEE) should be carefully arranged in modern electronics without compromising the legacies inherited from previous researches. Hence, dependable designs should be adopted to guarantee correct executions of the whole systenms.

Hamming type LBC, also known as a kind of perfect codes, have been widely adopted in the memories protections of electronics ranging from embedded micro-controller to high-end enterprise CPU, from customized ASICs to reconfigurable FPGAs. Of great importance is its simplicity and efficiency comparing to other coding methods. LBC encodes the partitioned blocks of k-bit data with r-bit redundancy, mainly with $n \gg r$ to improve coding rate for a large n.

In this paper, we survey the widely used linear block codes(LBC) and the codes construction methods. The preliminary concepts and inferences are firstly reviewed to get the relationship of error control capability and the minimum distances of LBC. Then, various constructing methods for codes with diverse error control ability are sumumanzed and compared in this paper. Also proposed in this paper is a truly realized fault-tolerant digital signal processor (DSP) with the adoption of LBC in micro-architecture pipeline to show how LBC conributes to system dependancy. We hope this paper would be a concise understanding to LBC and a brief reference for digital engineers building a reliable spaceborne electronic system.